* NOTICES *

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]This invention relates to the circulated type minute mixer, the mixed device, and liquid mixing method which mix a fluid using a minute channel.
[0002]
[Description of the Prior Art]The device which makes it mix, circulating two or more fluids in recent years using the channel of a very small passage sectional area, and makes various minute chemical reactions cause attracts attention, and a circulated type minute mixer (only henceforth a minute mixer) becomes indispensable at this device. Since the passage sectional area is very small to a minute mixer, a little volume of a reagent and a sample comes out, it comes out enough and the specific surface area (surface area per unit volume) of the fluid in a merging route becomes large in addition to a certain thing, there is a merit of the ability to make it react efficiently by obtaining high cooling efficiency in it. For this reason, a minute mixer is used in many cases in order to make the reaction of a reagent and an inspection body aiming at a synthetic reaction or an inspection aiming at production of a predetermined substance perform.
[0003]Drawing 11 is an example of the general composition of a minute mixer. This minute mixer offers the merging route 102 formed by the introductory passages 101A and 101B and the introductory passages 101A and 101B of plurality (here two) joining, and is constituted. Fluid F_A and F_B which were introduced into the introductory passages 101A and 101B, respectively join by the merging route 102.
Since the channels 101A, 101B, and 102 are channels of a minute section, circulation of fluid F_A and F_B is made to perform using ********, or it is made to perform using pressure drives, such as a syringe pump.

[0004]
[Problem(s) to be Solved by the Invention]By the way, if fluid F_A reaches a merging section at an early stage rather than fluid F_B of another side as while shows drawing 12, between the upstream end of fluid F_A, and the upstream end of fluid F_B, a gas will be sealed and the above-mentioned gap G will be formed of this gas. And since an adverse effect will arise in circulation of these fluid F_A and F_B, diffusion/mixing, or a chemical reaction if such a gap G is formed between fluid F_A and F_B, controlling circulation of fluid F_A and F_B suitably -- two or more fluids -- abbreviated -- although it is preferred to make a merging section reach simultaneously, the circulation control with such high accuracy is very difficult.
[0005]That is, in moving a fluid using capillarity. The wettability of the wall surface on which capillarity faces the surrounding environment (a pressure, temperature) and a channel, an angle of contact, free energy, etc., In order to change with the viscosity of a fluid, density, surface tension, the interfacial tension of the wall surface and fluid facing a channel, a passage sectional area, the depth, and various elements, such as the channel depth, delicately, the above highly precise circulation control is difficult.
[0006]In using capillarity in this way, the introduction to the introductory passage of a fluid -- simultaneously -- since a fluid starts movement naturally -- two or more fluids -- abbreviated, in order to make a merging section reach simultaneously, It is difficult for it to be necessary to introduce two or more channels into an introductory passage corresponding, respectively to proper timing, and even for this point to make two or more fluids reach abbreviated coincidence at a merging section.
[0007]When only controlling circulation by the voltage adjustment in an electroendosmose style, or pressure regulation in a pressure drive, since there is a control delay, the above highly precise circulation control is difficult. It is difficult to drive a fluid with high voltage, since pressure loss becomes high by a fine channel especially in a pressure drive, and to perform circulation control with high precision under such high voltage.
[0008]In addition, provide the micro valve which carries out minute displacement of a piezo-electric element or the elastic body (for example, polymers, such as estramer), and opens and closes a channel near the downstream end of each introductory passage (right above [a merging section] style part), and the operation of this micro valve is controlled, It can consider making the fluid in each introductory passage flow into a merging section simultaneously. That is, where each micro valve is closed, a fluid is moved, and after all the fluids stop in a right above [a merging section] style part, the fluid in each introductory passage is made to flow into a merging section simultaneously by opening the micro valves of each introductory passage all at once.
[0009]However, since it requires time and effort for manufacture while the micro valve needs

an advanced design although it is minute therefore, it will become expensive, and the attachment work to an infinitesimal channel will turn into delicate work, and a still more complicated control mechanism will be needed. An object of this invention is to provide the minute mixer and the mixed device which can manufacture easily by having been originated in view of such a technical problem, and enabled it to mix a fluid efficiently with simple composition.

[0010]

[Means for Solving the Problem]For this reason, a circulated type minute mixer (claim 1) of this invention, Two or more introductory passages which have a section of a respectively minute equivalent diameter, and a merging route formed by having a section of a minute equivalent diameter and two or more above-mentioned introductory passages joining are offered, In a circulation type [which makes a fluid introduced from two or more above-mentioned introductory passages join / react by this merging route] minute mixer, Rather than an internal surface which forms this introductory passage, a low low affinity part of compatibility to this fluid is characterized by a thing of a merging section of this introductory passage immediately provided in this a part of internal surface in the upstream.

[0011]In this case, 1 set of low low affinity part of compatibility to this fluid may be provided as an injection point of this fluid to this introductory passage is inserted (claim 2). It is preferred that an angle of contact [as opposed to water in this low affinity part] is constituted with material of 80 degrees or more (claim 3). An affinity degree change member from which a degree of this compatibility changes according to a temperature change may constitute this low affinity part (claim 4).

[0012]A mixed device (claim 5) of this invention is characterized by offering a circulated type minute mixer of a statement, and a fluid means of transport for conveying this fluid in this circulated type minute mixer on which paragraph of claims 1-4, and being constituted. In this case, it is preferred that this fluid means of transport is constituted by voltage control means which controls one pair of electrodes attached in this introductory passage and voltage inter-electrode [this] (claim 6).

[0013]Or it is preferred that this fluid means of transport is constituted by pressure driving means which drives with a pressure (claim 7). Or it is preferred that this fluid means of transport is constituted by temperature control means which controls temperature of this affinity degree change member and this affinity degree change member (claim 8). A liquid mixing method (claim 9) which uses a circulated type minute mixer of this invention, On this low affinity part provided in a step which introduces this fluid into an introductory passage of this plurality, respectively, and an introductory passage of each of this plurality in a circulated type minute mixer given in any 1 paragraph of claims 1-4, After this fluid in an introductory passage of this plurality stops circulation, respectively, it is characterized by offering a step

which resumes transportation to this merging route of this fluid, and being constituted.

[0014]

[Embodiment of the Invention]Hereafter, an embodiment of the invention is described with reference to drawings. Each following embodiment explains the fluid mixed with a minute mixer as a water-soluble fluid. The dispersed system of a suspension, colloid, etc. is also included with a fluid here. The canal part as used in the field of below means the portion whose degree of affinity is lower than the solid phase wall surface (internal surface) which forms an infinitesimal channel to the fluid which circulates an infinitesimal channel, and the degree of affinity contains what becomes lower than a solid phase wall surface depending on temperature as well as what has the degree of affinity regularly lower than a solid phase wall surface.

[0015]First, the minute mixer and the mixed device as a 1st embodiment of this invention are explained. Drawing 1 - drawing 6 are the figures showing the minute mixer and the mixed device of this embodiment. It is for the mixed device as a 1st embodiment of this invention mixing two or more kinds (here two kinds) of different fluid F_A and F_B, and carrying out a synthetic reaction, The minute mixer later mentioned using drawing 1 and the fluid means of transport which are established about each of the introductory passages 11A and 11B of a minute mixer and which is not illustrated are offered, and it is constituted. A fluid means of transport is a means for conveying fluid F_A and F_B which were poured in into the minute mixer, Here, for example, a pressure drive conveys, it is constituted by pressure driving means like a syringe pump, and is connected to each of inlet 11Aa of a minute mixer, and 11Ba dismountable.

[0016]It may be made to constitute from a voltage control means which adjusts the voltage between the electrode (electric drive part) E1 of the couple shown by 2 point lead lines, E2 and these electrodes E1, and E2 into drawing 1 in which the fluid means of transport was provided by the upstream of the canal part 14 (this is mentioned later) instead of the pressure driving means. In such composition, by applying prescribed voltage between the electrode E1 and E2, an electroendosmose style can be generated to fluid F_A and F_B, and fluid F_A and F_B can be moved now in a channel.

[0017]As shown in drawing 1, a minute mixer two or more (here two) for circulating the above-mentioned fluid F_A and F_B, respectively Now, the minute introductory passages 11A and 11B, The minute reaction way (merging route) 12 which makes the above-mentioned fluid F_A and F_B mix / react is offered, and it is constituted. That it is minute means the size of the extent here which can convey a fluid certainly in each channel according to capillarity, and the equivalent diameter (a =4x passage sectional area / passage cross section boundary length)

of a passage cross section, It is preferred that it is in the range of 0.01 mm - 2 mm, and it is still more preferred that it is in the range which are 0.05 mm - 1 mm.

[0018]The merging route 12 makes the introductory passages 11A and 11B join, and is formed, and the merging section 12a which makes it come to join the downstream end of the introductory passages 11A and 11B together is formed as an upstream end. Inlet 11Aa and 11Ba which inject a fluid into the upstream end of the introductory passages 11A and 11B from the exterior are provided, respectively, and the limb 12b is formed in the downstream end of the merging route 12 as a storing section which collects the mixture of fluid F_A and F_B. The vent 12c is formed in the limb 12b so that the fluid in the channels 11A and 11B and 12 can move.

[0019]Each channels 11A, 11B, and 12 are formed here as a closed space which has a cross section of the rectangle formed between the substrate 20 and the lid 21 by attaching the lid 21 to a side with this slot 20a to the substrate 20 with which the slot 20a on the specified shape was formed, as shown in drawing 2 (a). Or by sticking on the substrate 20 the filmy thing 22 in which the through hole 22a of specified shape was formed, as shown in drawing 2 (b), and attaching the lid 21 to the side which does not touch the substrate 20 of the filmy thing 22 further, It may be made to form a closed space formed between the substrate 20, the lid 21, and the filmy thing 22 as the channels 11A, 11B, and 12. Anyway, the channels 11A, 11B, and 12 are the substrate 20 and the lid 21. By the composition shown in [drawing 2 (b), it is filmy thing 22] further. It will be constituted by the internal surface (solid phase wall surface) 13, ** and others.

[0020]and -- as a big feature of this invention, as shown in drawing 1, they are a part of introductory passages 11A and 11B -- the merging section 12a -- the canal part (low affinity part) 14 is immediately formed in the upstream, respectively. Here, the canal part 14 is formed over the perimeter of the solid phase wall surface 13 so that the passage cross section of the introductory passages 11A and 11B may be enclosed. A canal here means that the compatibility (here hydrophilic nature) over fluid F_A and F_B is lower than the solid phase wall surface 13 which consists of substrate 20 grade. That is, the relative character determined as a standard in the compatibility over fluid F_A of the solid phase wall surface 13 and F_B is meant.

[0021]Thus, by forming the canal part 14, If fluid F_A and F_B are poured into the introductory passages 11A and 11B from inlet 11Aa and 11Ba by a syringe etc. as shown in drawing 3 (a) (the pressure driving means is removed from inlet 11Aa and 11Ba in this state), As shown in drawing 3 (b), fluid F_A and F_B move toward the merging route 12 according to capillarity. And if the canal part 14 is reached as shown in drawing 3 (c), fluid F_A and F_B will try to stop at the

introductory passages 11A and 11B where compatibility is higher than the canal part 14. As a result, fluid F_A and F_B resist capillarity and stop by the upstream (immediately upstream [Namely, the merging section 12a]) of the canal part 14.

[0022]And as shown in drawing 3 (c), after each of fluid F_A and F_B stops in the canal part 14, if fluid F_A and F_B connect with inlet 11Aa and 11Ba and operate a pressure driving means from this state stopped near the pole of the merging section 12a -- fluid F_A and F_B -- abbreviated -- it can be made to flow into the merging section 12a simultaneously now Circulation prohibitive power required to resist such capillarity and stop fluid F_A and F_B, It is preferred that are mainly determined by the hydrophobicity (compatibility) of the canal part 14 to fluid F_A and F_B, and the angle of contact over fluid F_A and F_B uses the thing of 70 degrees or more as construction material of the canal part 14 so that the below-mentioned example may explain.

[0023]The ratio (a canal part length ratio, a low affinity part length ratio) alpha of circumferential length in which the canal part [as opposed to / besides an angle of contact / the equivalent diameter D of the introductory passages 11A and 11B and the boundary length of a passage cross section in the circulation prohibitive power of the canal part 14] 14 is formed more particularly [-- here, in the example shown in alpha= 1, for example, drawing 4, since the canal part 14 is formed over the perimeter of a passage cross section, it is greatly dependent on alpha=$L_1/(2L_2+2L_3)$]. Therefore, their thing by which the following conditions 1 - conditions 3 are fulfilled and which is set [like] up like is preferred so that the construction material of the canal part 14 and the canal part length ratio alpha may stop fluid F_A and F_B which circulate the inside of the introductory passage 11A and 11B according to capillarity.

[0024](Conditions 1) When the equivalent diameters D of the introductory passages 11A and 11B are 0.2 mm - 2 mm, It is preferred that set the canal part length ratio alpha or more to 0.2, and the angle of contact theta over fluid F_A and F_B uses for a canal part the construction material which is 70 degrees or more on the assumption that hydrophobicity is higher than the solid phase wall surface 13 in the construction material of the canal part 14.

(Conditions 2) When the equivalent diameters D of the introductory passages 11A and 11B are 0.02 mm - 0.2 mm, again, It is preferred that set the canal part length ratio alpha or more to 0.25, and the angle of contact theta over fluid F_A and F_B uses for a canal part the construction material which is 70 degrees or more on the assumption that hydrophobicity is higher than the solid phase wall surface 13 in the construction material of the canal part 14.

[0025](Conditions 3) Further, when the equivalent diameters D of the introductory passages 11A and 11B are 0.01 mm - 0.02 mm, It is preferred that set the canal part length ratio alpha or more to 0.4, and the angle of contact theta over fluid F_A and F_B uses for the construction

material of the canal part 14 the construction material which is 70 degrees or more as a canal part on the assumption that hydrophobicity is higher than the solid phase wall surface 13.
[0026]When the kind of fluid used as fluid F_A and F_B is not specified, it is preferred to use the construction material whose angle of contact theta is 70 degrees or more as a canal part about all of the fluid in which use is expected in order to fulfill the above-mentioned conditions 1-3. In addition, it is premised on hydrophobicity being higher than the introductory passages 11A and 11B, It becomes a big rule of thumb of the material which can be used as construction material of the canal part 14 that the angle of contact theta over water is 80 degrees or more, and they are poly methyl methacrylate, polycarbonate, polyvinyl chloride, a wax, etc. as construction material of 80 angles of contact or more. It is more preferred that the angle of contact theta over water uses the construction material of 90 degrees or more for the canal part 14.
[0027]In this invention, the angle of contact theta uses the device of part number CA-A made from Harmony Surface chemistry, and means what was measured under the conditions of the ambient air temperature of 21.2-23.7 **, and 30 to 38% of ambient humidity. When the construction material of the solid phase wall surface 13 and the formation method of the channels 11A, 11B, and 12 are explained, they are the solid phase wall surface 13 20, i.e., a substrate, and the lid 21. With the composition shown in [drawing 2 (b), further the construction material of filmy thing 22], Although the kind in particular is not limited, since the compatibility over fluid F_A and F_B needs to be higher than the canal part 14, resin, ceramics, glass, metal, etc. need to grasp this compatibility characteristic.
[0028]Typical formation methods of the channels 11A, 11B, and 12 include the method of providing and forming the slot 20a in the substrate 20, as shown in drawing 2 (a), and the method of sticking on the substrate 20 the filmy thing 22 in which the through hole 22a of specified shape was formed as shown in drawing 2 (b), and forming it, as mentioned above. There is also the method of forming in the chip substrate (only henceforth a substrate) 20 and one by one molding of stereolithography etc.
[0029]As a method of forming the slot 20a in the substrate 20, For example, transfer technology, dry etching (RIE, IE, IBE, the plasma etching, laser etching, the laser abrasion, blasting, the electron discharge method, LIGA, electron beam etching, FAB) which are represented by machining, and injection molding and compression molding, The channel by wet etching (chemicals corrosion) etc., or etching for a slot, There are a coat, vacuum evaporation, sputtering, Surface Micro-machining that forms a fine structure thing by depositing and removing selectively, etc. in layers about one molding of the Mitsuzo form, ceramic ****, etc., and various substances.
[0030]As paste procedure of the filmy thing 22 in the case of sticking the filmy thing 22 on the substrate 20, and forming a channel, The combination by the combination by adhesion by adhesives, the resin junction by a primer, diffused junction, anode joining, eutectic bonding,

thermal melting arrival, ultrasonic jointing, laser fusing, and a solvent and a dissolution solvent paste together and according to adhesive tape, adhesive tape, sticking by pressure, and self-adsorbent, physical maintenance, and unevenness is mentioned.

[0031]When the formation method of the canal part 14 is explained, the formation method of the canal part 14, For example, the method of carrying out hydrophobing (reduction in an affinity) of the solid phase wall surface 13 (substrate 20 grade) selectively and this have the method of carrying out hydrophilization (raise in an affinity) of the portion except the predetermined part (canal part 14) of the solid phase wall surface 13 (substrate 20 grade) conversely. When using hydrophobic materials, such as an acrylic resin, polycarbonate, polystyrene, silicon, polyurethane, polyolefine, polytetrafluoroethylene, polypropylene, polyethylene, and thermoplastic elastomer, for the solid phase wall surface 13, as a method of carrying out hydrophilization of this, the method (a plasma process and ion implantation.) accompanied by the grant to the surface of the hydrophilic functional group or hydrophilic molecule depending on surface coating, wet chemical modification, gas reforming, surfactant treatment, corona discharge, the formation of a sparse side, metaled vacuum evaporation, metaled sputtering, ultraviolet treatment, and processing atmosphere The lasing etc. are mentioned.

[0032]When using hydrophilic materials, such as glass, metal, and ceramics, for the solid phase wall surface 13, as a method of carrying out hydrophobing of this selectively, The methods (a plasma process, ion implantation, lasing, etc.) accompanied by the grant to the surface of the hydrophobic functional group or hydrophobic molecule depending on the surface coating of hydrophobic substances, such as adhesives and a low, a surface grafting method, and processing atmosphere are mentioned.

[0033]Thus, when performing refining (hydrophilization or hydrophobing) of the solid phase wall surface 13, direct processing may be performed into a refining portion, and after covering a non-refining portion with a mask etc., it may process to an opening. That is, as shown in drawing 5 (a) and (b), the channel 30 is formed from the solid phase wall surface of hydrophilic nature, A canal part may be formed only in the prescribed spots 31 and 32 of this solid phase wall surface using the above-mentioned reforming method, or the channel 30 may be formed from a hydrophobic solid phase wall surface, and the canal parts 31 and 32 may be relatively formed only in the part except the prescribed spots 31 and 32 of this solid phase wall surface, using the above-mentioned hydrophilization method directly.

[0034]As shown in drawing 6 (a), (b), and (c), the channel 30 is formed from the solid phase wall surface of hydrophilic nature, After attaching to a prescribed spot the mask 35 which has the openings 33 and 34 to a solid phase wall surface, it may be made to form the inside 31 and 32 of the opening 33 and 34, i.e., prescribed spots, as a canal part by enforcing the above-mentioned hydrophobing method to the range covering the whole solid phase wall surface. Or

after carrying out the mask only of the prescribed spots 31 and 32, by using the above-mentioned hydrophilization method to the range covering the whole solid phase wall surface, hydrophilization of the part except the prescribed spots 31 and 32 may be carried out, and the canal parts 31 and 32 may be formed relatively.

[0035]It is also possible to form a partial pattern by assembling the hydrophilic nature of another kind and a hydrophobic material. That is, hydrophobic construction material is stuck on the solid phase wall surface 13 of hydrophilic nature, for example, and it may be made to form a canal part. Since the minute mixer and the mixed device as a 1st embodiment of this invention are constituted as mentioned above, mixing of a fluid is performed by the following techniques (liquid mixing method which uses the minute mixer as a 1st embodiment of this invention). Hereafter, explanation is advanced with reference to drawing 1.

[0036]First, where a syringe pump is removed from inlet 11Aa and 11Ba, fluid F_A and F_B are poured into the introductory passages 11A and 11B from inlet 11Aa and 11Ba by a syringe etc. This fluid F_A and F_B which were poured into the introductory passages 11A and 11B move toward the merging section 12a according to capillarity, and stop in the canal part 14. And if it connects with inlet 11Aa and 11Ba and a syringe pump is operated after each of fluid F_A and F_B stops in the canal part 14, exhaust air will be supplied by the syringe pump and fluid F_A and F_B will drive via this exhaust air. thereby -- fluid F_A and F_B -- fluid F_A [from / near the pole of the merging section 12a], and F_B -- abbreviated -- it can be made to flow into the merging section 12a simultaneously

[0037]Or even if a difference arises to the timing to which fluid F_A and F_B reach the merging section 12a, Since the distance of each canal part 14 and the merging section 12a is very slight, this timing difference will also become [few / very] and exhaust air will not mix it between fluid F_A and F_B. That is, a big difference is between time for fluid F_A to reach the merging section 12a and time for fluid F_B to reach the merging section 12a, If the tip of fluid F_B has not reached the merging section 12a when the tip (downstream end) of fluid F_A passes the merging section 12a thoroughly, as shown in drawing 12 used as a technical problem of conventional technology, Exhaust air will be sealed by fluid F_A and F_B and it will mix in them (this sealed exhaust air is called air plug).

[0038]However, in this minute mixer, the difference to the timing which reaches the merging section 12a in which fluid F_A and F_B are big as mentioned above does not arise, Since the tip of the fluid of the other already comes to reach the merging section 12a when the tip of one of fluids passes the merging section 12a thoroughly, an air plug does not occur between fluids. With therefore, the simple composition of forming the canal part 14 in the introductory

passages 11A and 11B. Being able to prevent generating of the gap between fluid F_A and F_B substantially, fluid F_A and mixed ****** of F_B have the advantage that it is stabilized and the transport process and synthetic reaction which are performed after that can be performed.

[0039]Since composition is simple, it can manufacture, and there is an advantage that it can mass-produce easily. Next, the minute mixer as a 2nd embodiment of this invention is explained. Drawing 7 is a figure showing the minute mixer and the mixed device of this embodiment. The numerals same about the member explained by a 1st above-mentioned embodiment are attached, and the explanation is omitted. Drawing 1 used by a 1st above-mentioned embodiment is also diverted and explained.

[0040]The minute mixer as a 2nd embodiment of this invention constitutes the canal part 14 by an affinity degree change member to the minute mixer of a 1st embodiment shown in drawing 1. Say an affinity degree change member and that from which the compatibility over fluid F_A and F_B which circulate the introductory passages 11A and 11B according to a temperature change changes here, PIPAAm which the temperature induction gel (affinity degree change member) which is the polymer gel from which hydrophilic nature changes according to a temperature change is used, and is typical as especially such temperature induction gel [Poly (N-isopropylacrylamide)] Gel is used.

[0041]If it will hydration-ize if it becomes low temperature, and it becomes an elevated temperature, in order to form the drying sum, if this PIPAAm gel becomes low temperature according to this, hydrophilization of it will be carried out, and if it becomes an elevated temperature, hydrophobing of it will be carried out. Hydrophilization of the solution of liner polymer of PIPAAm is carried out at the temperature below LCST (Lower CriticalSolutionTemperature), and it has the feature which carries out hydrophobing at a temperature higher than LCST.

[0042]LCST of PIPAAm is about 32 ** and temperature control is easily possible for it by the usual heating cooler style. That is, since temperature control width (namely, LCST-T_{ATM}) required to reverse hydrophilicity/canal since LCST is the atmospheric temperature T_{ATM} circumference is small, it is easy to perform temperature control. As other temperature sensitivity gels, the copolymer of DEAAm (N,N-diethylacrylamide) gel (LCST = 25-32 **), pAPP (Polly N-acryloyl piperidyl) gel (LCST**5 **), and the above-mentioned polymer is mentioned. It is also possible to adjust LCST with pH of an operating environment, a copolymerization ratio, etc.

[0043]In addition to the above-mentioned minute mixer, the mixed device of this embodiment as a fluid means of transport which conveys the introductory passage 11A, fluid F_A in 11B, and F_B, The introductory passage 11A and the temperature controller (temperature control means)

40 which is formed for 14 copies of every canal parts (here temperature induction gel) in 11B, and controls the temperature of the canal part 14 are offered, and it is constituted. The electrothermal plate (for example, copper plate etc.) 41 which was embedded in the substrate 20 and connected to the canal part 14, respectively as each temperature controller 40 was shown in drawing 7 (a), The thermo couple (temperature sensor) 41a attached to this electrothermal plate 41, Peltier device 42 which heats / cools the canal part 14 via the electrothermal plate 41a, the heat sink (heat sink) 43 which polymerized in Peltier device 42, and the control device 44 are offered, and it is constituted.

[0044]According to the voltage supplied, Peltier device 42 the control device 44, [generation of heat / carrying out an endothermic and] The canal part 14 carries out feedback control of the voltage supplied to Peltier device 42 based on the canal part temperature information detected by the thermo couple 41a so that it may become the prescribed temperature inputted from the input means which is not illustrated. In the temperature controller 40, as a temperature sensor, as shown in drawing 7 (b), the infrared sensor 41b may be used instead of the thermo couple 41a. As shown in drawing 7 (c), Peltier device 42 may be embedded in the substrate 40 via the electrothermal plate 41, and direct continuation may be carried out to the canal part 14.

[0045]Since the minute mixer and the mixed device as a 2nd embodiment of this invention are constituted as mentioned above, mixing of a fluid is performed as follows. That is, after controlling via the control device 44 first to carry out hydrophobing of the temperature of the canal part 14 if required, fluid F_A and F_B are poured into the introductory passages 11A and 11B from inlet 11Aa and 11Ba by a syringe etc. This fluid F_A and F_B which were poured into the introductory passages 11A and 11B move toward the merging section 12 according to capillarity, and stop in the canal part 14.

[0046]And after each of fluid F_A and F_B stops in the canal part 14, the temperature of the canal part 14 is controlled via the control device 24, and hydrophilic nature is made to reverse the canal part 14. By this, fluid F_A and F_B resume movement according to capillarity, and it flows into abbreviated coincidence at the merging section 12a, therefore the same effect as a 1st embodiment of the above is acquired. Since a minute mixer has a minute substrate etc. which form a minute mixer and its calorific capacity is small, it is comparatively short response time, Circulation control of the temperature control, i.e., fluid F_A, of the heat induction gel (canal part) 14 and F_B can be performed, and there is an advantage of synchronizing the circulation control in each introductory passages 11A and 11B, and being easy to make it perform.

[0047]Next, the minute mixer as a 3rd embodiment of this invention is explained. Drawing 8 is a figure showing the minute mixer as a 3rd embodiment of this invention. The numerals same about the member explained by a 1st above-mentioned embodiment and a 2nd embodiment

are attached, and the explanation is omitted. The minute mixer of this embodiment is constituted as an inspecting chip. An inspecting chip here is for making biochemical reactions, such as combination with an antigen-antibody reaction, protein, and protein, protein, a low-molecular combination, etc. perform in order to conduct a predetermined inspection to a sample liquid object, It is for conducting a predetermined inspection based on the reaction state of a sample liquid object and a reagent.

[0048]For this reason, as an inspecting chip is shown in drawing 8, while offering the introductory passage 11A, the introductory passage 11B, the merging route 12, and the canal part 14 like a 1st embodiment, The reagent attaching parts 15 and 15 by which reagent C_A and C_B are spotted / held, respectively are offered on each introductory passages 11A and 11B, respectively, and to the merging route 12. The limb 16 for performing optical detection etc. as opposed to the mixing liquid of a sample liquid object and a reagent is formed as a primary detecting element.

[0049]And the mixed device of this embodiment offers the inspecting chip shown in drawing 8, and the syringe pump (a fluid means of transport, pressure driving means) connected to inlet 11Aa of an inspecting chip, and 11Ab, respectively, and is constituted. Since the inspecting chip as a 3rd embodiment of this invention is constituted as mentioned above, an inspection is conducted as follows.

[0050]That is, first, inlet 11Aa to sample liquid object F_S is poured into the introductory passage 11A for example, from inlet 11Aa, and in a similar manner in the introductory passage 11B. Reagent C_A held at the attaching part 15 mentioned above and different reagent C_C from C_B are poured in from inlet 11Ba. After sample liquid object F_S and reagent C_C which were poured in move according to capillarity, respectively and are mixed with reagent C_A and C_B by the reagent attaching part 15, they stop in the canal part 14.

[0051]And a syringe pump is connected to inlet 11Aa and 11Ab, respectively, and if exhaust air is sent in from a syringe pump and the introductory passage 11A, the sample liquid object in 11B, and transportation of a reagent are started, these sample liquid objects and reagents will flow into the merging route 12 at abbreviated coincidence. Therefore, like each above-mentioned embodiment, it is stabilized and a sample liquid object and a reagent can be mixed efficiently. Subsequently, in the primary detecting element 16, predetermined detection is performed about this mixed liquor. Since a sample liquid object and a reagent are stabilized and are mixed, this detection can also be performed with sufficient accuracy.

[0052]And mixed liquor is summarized to the limb (waste fluid part) 12b formed in the downstream end of the merging route 12, and is collected. Although this embodiment showed the example which used the syringe pump (pressure driving means) as a fluid means of

transport, the electrode of a couple is inserted into the introductory passage 11A and 11B, and it may be made for an electroendosmose style to convey a fluid as a fluid means of transport. Or temperature induction gel constitutes the canal part 14, and it may be made to use the temperature controller which controls the temperature of temperature induction gel as a fluid means of transport.

[0053]Next, the minute mixer as a 4th embodiment of this invention is explained. Drawing 9 is a figure showing the minute mixer as a 4th embodiment of this invention. The numerals same about the member explained by each above-mentioned embodiment are attached, and the explanation is omitted. As the minute mixer of this embodiment is constituted as an inspecting chip like a 3rd embodiment and it is shown in drawing 9 to the inspecting chip of a 3rd embodiment, The canal part 14 and the canal parts 14a and 14b of the lot (two pieces) constituted similarly are formed in the upstream part of each introductory passages 11A and 11B, respectively.

[0054]Although sample liquid object F_S which sample inlet 11Aa to sample liquid object F_S was poured into the introductory passage 11A, for example, was poured into it from sample inlet 11Aa by the syringe etc. circulates the inside of the introductory passage 11A according to capillarity, It stops in the canal parts 14a and 14b of sample inlet 11Aa both sides. That is, the injection rate of sample liquid object F_S which can be poured in from sample inlet 11Aa by these canal parts 14a and 14b will be specified. That is, it has come to be able to carry out weighing of the sample liquid object F_S to the canal part 14a and the specified quantity determined according to the distance between 14b automatically.

[0055]Between the canal part 14a of the introductory passage 11B, and 14b, reagent C_C is poured in beforehand. The vent (graphic display abbreviation) is provided in each introductory passages 11A and 11B at the upstream of the canal part 14a, respectively so that a fluid can circulate. The mixed device as a 4th embodiment of this invention, The voltage control means which controls the voltage between this inspecting chip, the electrode (electric drive part) E1 and E2 which were provided between the canal part 14a and 14b to each introductory passages 11A and 11B, and these electrodes (electric drive part) E1 and E2 and which is not illustrated is offered, and it is constituted.

[0056]Since the inspecting chip and the mixed device as a 4th embodiment of this invention are constituted as mentioned above, an inspection is conducted as follows. That is, weighing of the sample liquid object F_S is poured in and carried out to the canal parts 14a and 14b of the introductory passage 11A from sample inlet 11Aa. And if prescribed period voltage is applied to the electrode E1 of the introductory passages 11A and 11B, and E2, sample liquid object F_S and reagent C_C between the canal part 14a and 14b will drive, and will overcome the canal

part 14b.

[0057]And sample liquid object F_S and reagent C_C will be isolated from the electrode E1 and E2 after that, if the canal part 14b is overcome, but they maintain movement according to capillarity. After being mixed with reagent C_A and C_B by the reagent attaching part 15, respectively, since voltage is not applied to the electrode E1 and E2, sample liquid object F_S and reagent C_C stop in the canal part 14 at this time. Since the interval of the canal part 14a and the canal part 14b is set up more greatly enough than the interval of the canal part 14b and the canal part 14, it will be in the state where sample liquid object F_S or reagent C_C exists between the canal part 14a and 14b in each introductory passages 11A and 11B, at this time.

[0058]Thus, if prescribed period voltage is again applied to the electrode E1 and E2 after each of sample liquid object F_S and reagent C_C stops in the canal part 14 of each introductory passages 11A and 11B, Sample liquid object F_S and reagent C_C between the canal part 14a and 14b drive, and the canal part 14b is overcome. And it drives in one, and the fluid of the merging route 12 which had stopped in the canal part 14 of the upstream immediately, respectively flows into the merging route 12, and is mixed with this sample liquid object F_S and reagent C_C. These mixing liquids are collected by the waste fluid part 12b after predetermined detection is performed in the process in which it passes through the primary detecting element 16.

[0059]When the upstream end of sample liquid object F_S which moves in the introductory passage 11A overcomes the canal part 14b, Since sample liquid object F_S is separated from the electrode E1 and E2, stop driving sample liquid object F_S which is between the canal part 14b and 14 at this time, and will not pass through the primary detecting element 16, but. Since it is set up small enough between the canal part 14b and 14 compared with between the canal part 14a and 14b (that is, to the quantity of sample liquid object F_S poured in into the introductory passage 11A) Since there is enough little quantity of sample liquid object F_S which remains between the canal part 14 and 14b, and does not contribute to an inspection, it can inspect with a sufficient system using sample liquid object F_S of sufficient quantity.

[0060]As mentioned above, it has come to be able to carry out weighing of the sample liquid object F_S by forming the canal parts 14a and 14b, but this weighing is the canal part 14 and the quantity which expected sample liquid object F_S which remains among 14b. Of course, it is also possible for temperature induction gel to constitute the canal part 14, to reverse hydrophilic nature, or to drive by a syringe pump, and to constitute so that a fluid may not be

made to remain between the canal part 14b and 14.

[0061]So that there may be no adverse effect to the reagent in the sample liquid object in the introductory passage 11A, or the introductory passage 11B, As shown in drawing 10, about each of the introductory passages 11A and 11B. The electrode E1 and the circumference of E2 are filled up with insoluble fluid (gas may be sufficient as well as fluid) F_X to these sample liquid objects and reagents, and it may be made to drive a sample liquid object and a reagent via this fluid F_X.

[0062]It is possible to change variously in the range which the minute mixer and the mixed device of this invention are not limited to each embodiment mentioned above, and does not deviate from the meaning of this invention. For example, although it had composition which provided two introductory passages in each embodiment mentioned above, it may be the composition that three or more introductory passages are provided. The minute mixer of a 1st embodiment shown in drawing 1 mentioned above can be used as an inspecting chip by pouring in sample liquid object F_S and a reagent from inlet 11Aa and 11Ab, respectively, and making the limb 12b into a primary detecting element, although explained as a chip for synthetic reactions. In this case, a part of merging route 12 is used as a primary detecting element, and it may be made to discharge waste fluid to the exterior from the outlet provided in the downstream end of the merging route 12, without forming the limb 12b. Or without forming the limb 12b, the mixed liquor of sample liquid object F_S and a reagent is discharged outside, and it may be made to perform predetermined detection in the exterior of an inspecting chip from the outlet provided in the downstream end of the merging route 12.

[0063]The limb 16 is not formed as a primary detecting element, but it may be made similarly to use a part of merging route 12 as a primary detecting element also in the minute mixer (inspecting chip) of a 3rd embodiment shown in drawing 8. It may be made to pour in not a reagent but a solvent in the minute mixer (inspecting chip) of a 4th embodiment shown in drawing 9 between the canal part 14a of the introductory passage 11B, and 14b. Even after sample liquid object F_S and reagent C_C overcome the canal part 14b, applying voltage to the electrode E1 and E2 is continued, and it may be made to maintain an electric drive. In this case, when sample liquid object F_S and reagent C_C reach the canal part 14, may stop an electric drive, but. Just before sample liquid object F_S and reagent C_C reach the canal part 14, an electric drive is stopped, and it is made more desirable [to move sample liquid object F_S and reagent C_C according to capillarity] until it reaches the canal part 14.

[0064]When the voltage applied to a fluid by the electrode pair of a lot is smaller than an initial complement, two or more sets of electrode pairs may be used.

[0065]

[Effect of the Invention]As explained in full detail above, according to this invention, the fluid poured in into each introductory passage moves according to capillarity in the inside of an introductory passage, but. By providing a low affinity part, it becomes possible to perform easily the thing of a merging section made for this fluid to flow into abbreviated coincidence to the merging section of the downstream immediately since an end stop can be immediately carried out by the upstream, and there is an advantage that these fluids can be mixed efficiently.

[0066]Since it is the simple composition which arranges a low affinity part to an introductory passage, there is an advantage that it can manufacture easily.

[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1]Two or more introductory passages which have a section of a respectively minute equivalent diameter, and a merging route formed by having a section of a minute equivalent diameter and two or more above-mentioned introductory passages joining are offered, In a circulation type [which makes a fluid introduced from two or more above-mentioned introductory passages join / react by this merging route] minute mixer, A circulation type [which is characterized by a thing of a merging section of this introductory passage immediately provided in this a part of internal surface in the upstream] minuter [than an internal surface which forms this introductory passage / a low low affinity part of compatibility to this fluid] mixer.
[Claim 2]The circulated type minute mixer according to claim 1 as a low low affinity part of compatibility to this fluid sandwiches an injection point of this fluid to this introductory passage, wherein it is provided 1 more set.
[Claim 3]The circulated type minute mixer according to claim 1 or 2, wherein an angle of contact [as opposed to water in this low affinity part] is constituted with material of 80 degrees or more.
[Claim 4]The circulated type minute mixer according to claim 1 or 2, wherein this low affinity part is constituted by affinity degree change member from which a degree of this compatibility changes according to a temperature change.
[Claim 5]A mixed device which offering a circulated type minute mixer of a statement, and a fluid means of transport for conveying this fluid in this circulated type minute mixer on which paragraph of claims 1-4, and constituting.
[Claim 6]The mixed device according to claim 5, wherein this fluid means of transport is constituted by voltage control means which controls one pair of electrodes attached in this introductory passage, and voltage inter-electrode [this].

[Claim 7]The mixed device according to claim 5, wherein this fluid means of transport is constituted by pressure driving means which drives with a pressure.
[Claim 8]The mixed device according to claim 5, wherein this fluid means of transport is constituted by temperature control means which controls temperature of this affinity degree change member and this affinity degree change member.
[Claim 9]On this low affinity part provided in a step which introduces this fluid into an introductory passage of this plurality, respectively, and an introductory passage of each of this plurality in a circulated type minute mixer given in any 1 paragraph of claims 1-4, A liquid mixing method which offering a step which resumes transportation to this merging route of this fluid, and constituting after this fluid in an introductory passage of this plurality stops circulation, respectively and which uses a circulated type minute mixer.

[Translation done.]

る。

【００６６】また、導入流路に低親和部を配置するだけの簡素な構成なので、容易に製造できるという利点がある。

【図面の簡単な説明】

【図１】本発明の第１実施形態及び第２実施形態としての微小混合器の構成を示す模式的な平面図である。

【図２】本発明の第１実施形態としての微小混合器の構成を示す図であり、（ａ）は模式的な横断面図であり図１のＸ－Ｘ断面に相当する図、（ｂ）は模式的な側面図であって（ａ）の変形例を示す図である。

【図３】（ａ），（ｂ），（ｃ）は本発明の第１実施形態としての微小混合器の作用を説明するための図であって微小混合器の模式的な平面図である。

【図４】本発明の第１実施形態にかかる疎水部長さ比率（低親和部長さ比率）αの定義を説明するための模式図であって、図１のＸ－Ｘ断面に相当する模式図である。

【図５】（ａ），（ｂ）は本発明の第１実施形態にかかる固相壁面の改質方法を説明するための図であって微小混合器の要部平面図である。

【図６】（ａ），（ｂ），（ｃ）は本発明の第１実施形態にかかる固相壁面の改質方法を説明するための図であって微小混合器の要部平面図である。

【図７】（ａ），（ｂ），（ｃ）は本発明の第２実施形態としての混合装置にかかる温度制御装置の構成を示す図であって、図１のＹ－Ｙ断面に相当する模式図である。

【図８】本発明の第３実施形態としての微小混合器の構成を示す模式的な平面図である。

【図９】本発明の第４実施形態としての微小混合器の構成を示す模式的な平面図である。

【図１０】本発明の第４実施形態としての微小混合器の変形例の構成を示す模式的な平面図である。

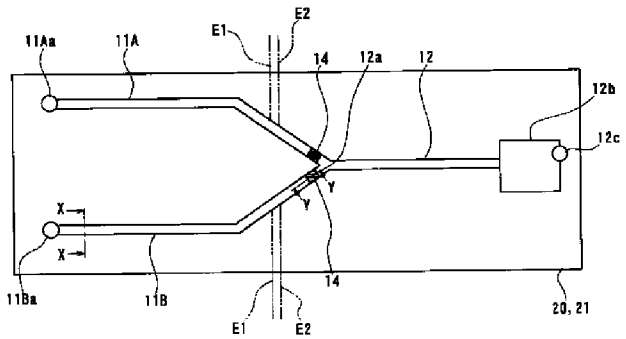
【図１１】従来の微小混合器の構成を示す模式的な平面図である。

【図１２】従来の微小混合器の課題を説明するための図であって微小混合器の合流部を示す模式的な平面図である。

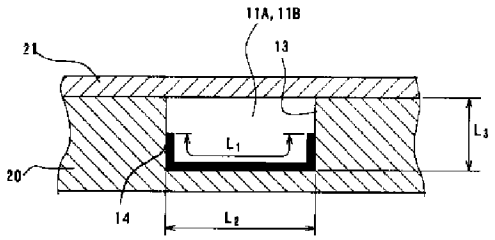
【符号の説明】

１１Ａ，１１Ｂ　導入路
１１Ａａ，１１Ｂａ　注入口
１２　合流路
１２ａ　合流部
１２ｂ　拡大部
１２ｃ　通気口
１３　固体壁面
１４，１４ａ，１４ｂ　疎水部（低親和部）
１５　試薬保持部
１６　検出部
２０　基板
２０ａ　溝
２１　蓋
２２　薄膜状物
２２ａ　貫通穴
３０　流路
３１，３２　流路３０の所定個所
３３，３４　開口部
３５　マスク
４０　温度制御装置
４１　電熱板
４１ａ　熱電対
４１ｂ　赤外線センサ
４２　ペルチェ素子
４３　ヒートシンク
４４　制御装置
Ｅ１，Ｅ２　電極（電気駆動部）

【図１】



【図４】



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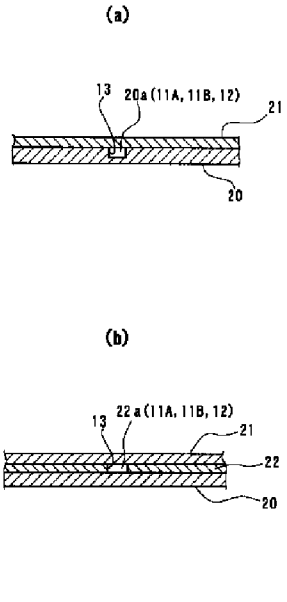

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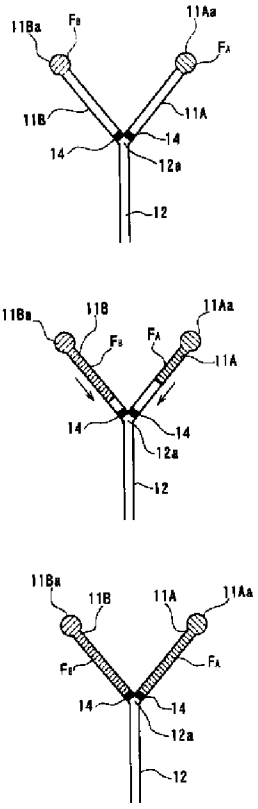

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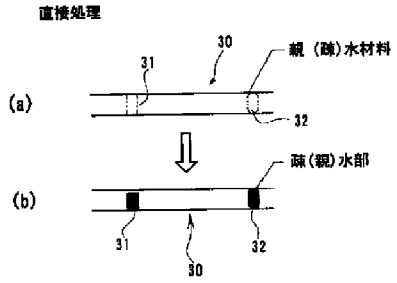

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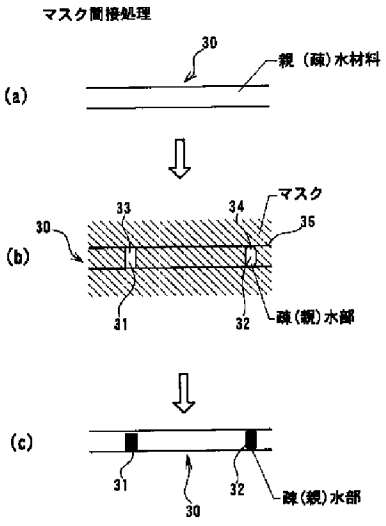

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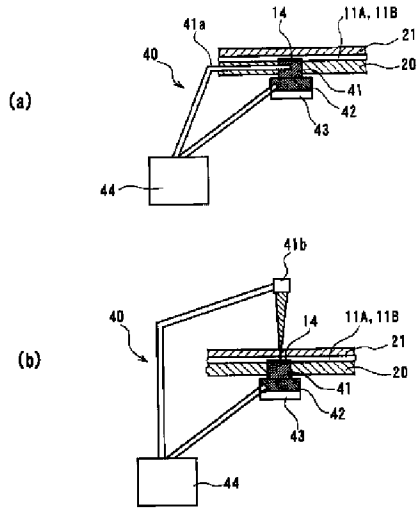

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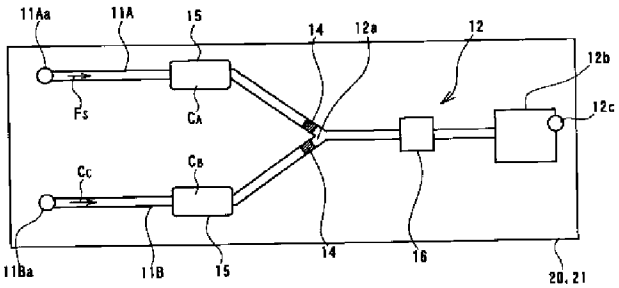

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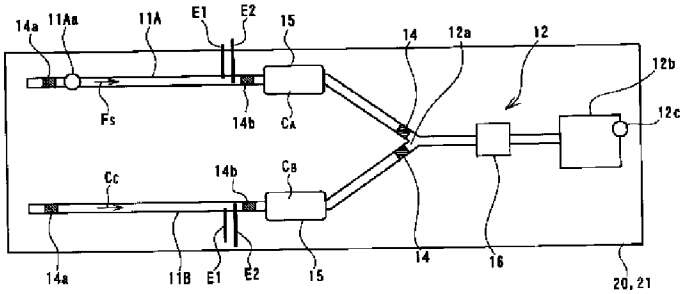
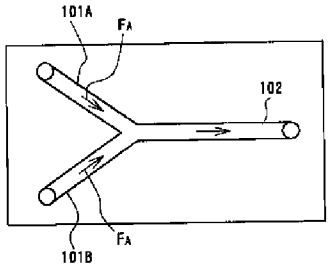


【図１１】



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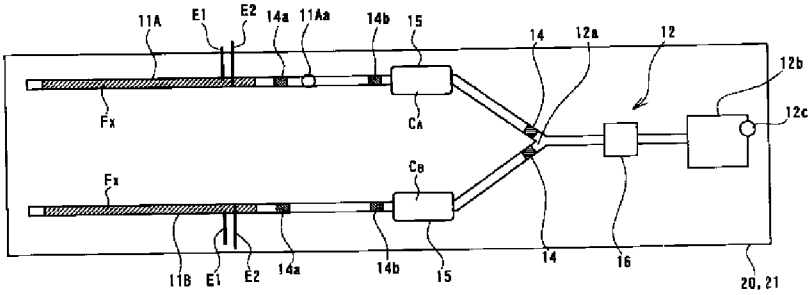

【図１２】